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RAINFALL RUNOFF MODELING: A CASE STUDY OF DELHI

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ABSTRACT

Runoff is an essential hydrological parameter for any catchment area, drainage basin or watershed as it gives information about the amount of water available at the outlet of a catchment, storage potential of the area, etc. The Soil Conservation Service Curve Number (SCS-CN) method is extensively used for predicting direct runoff volume for a given rainfall event from ungauged small watersheds. The applicability of the SCS-CN method and the runoff generation mechanism were thoroughly analyzed in an experimental watershed karol Bagh region in Delhi. This method takes into account many factors that affect runoff generation including soil type, land use and treatment, surface condition, and antecedent moisture condition (AMC), incorporating them in a single CN parameter. Moreover, it is the only approach that features readily grasped and reasonably well documented environmental inputs. In this paper, the hypothesis that the observed the calculated CN value and the rainfall depth in a watershed reflects the effect of soils and land cover on its hydrologic response

***KEYWORDS:** Runoff, SCS-CN Method, CN Parameter, Catchment Area*

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INTRODUCTION

The Soil Conservation Service Curve Number (SCS-CN) method (SCS, 1956, 1964, 1971, 1993) converts rainfall to surface runoff or rainfall excess. SCS-CN method is a simple technique that helps us determine the runoff from watersheds. Prediction of runoff is an important hydrological approach that is extremely vital for hydrologic system investigation. It aids in flood design, reservoir operation and water balance calculation models. Hjelmfelf (1991), Hawkins (1993), Bonta (1997), Mishra and Dwivedi (1998) suggested procedures for determining curve numbers and provided an analytical treatment of the SCS-CN methodology.

The SCS-CN method is a conceptual model of hydrologic abstraction of storm rainfall, supported by empirical data. Its objective is to estimate direct runoff volume from storm rainfall depth, based on a curve number CN .The SCS Runoff Curve Number method is developed by the United States Department of Agriculture (USDA) Soil Conservation Service (SCS) and is a method of estimating rainfall excess from rainfall (Hjelmfelt, 1991). This method was first devised by the SCS (US department of agriculture) and it is documented in the National Engineering Handbook, sect4; hydrology (NEH-4). Curve Number is essentially a coefficient that reduces the total precipitation to runoff potential, after "losses" – Evaporation, Absorption, Transpiration, and Surface Storage. Therefore the higher the CN value the higher the runoff potential will be (Basic Hydrology – Runoff Curve Numbers By: Paul Schiariti, P.E., and CPESC). The curve number method (SCS, 1972), also known as the hydrologic soil cover complex method, is a versatile and widely used procedure for runoff estimation. This method is currently known as the Natural Resources Conservation Service (NRCS)-CN method. The major reasons for its universal acceptance are that it takes into account watershed characteristics, namely soil type, land use/treatment,

surface conditions and antecedent moisture conditions (preceding wetness conditions). AMC is also referred as ARC (antecedent runoff condition). AMC is categorized into three levels, AMC I. AMC II and AMC III. AMC I refer to the dry conditions, AMC II refers to the normal or average conditions and AMC III refers to the wet condition of the watershed. Higher the AMC, higher is the CN and higher is the run off potential.(water resources management,2004, Mishra ,s. k)Another advantages include that its features are readily grasped, well establishes and accepted for use in the Unites States and other countries. It is easy to apply. This method was originally developed for its use on small agricultural areas and has been extended and applied to rural forest and urban watersheds. It has been applied to a wide range of environments since then.

REVIEW OF THE METHOD

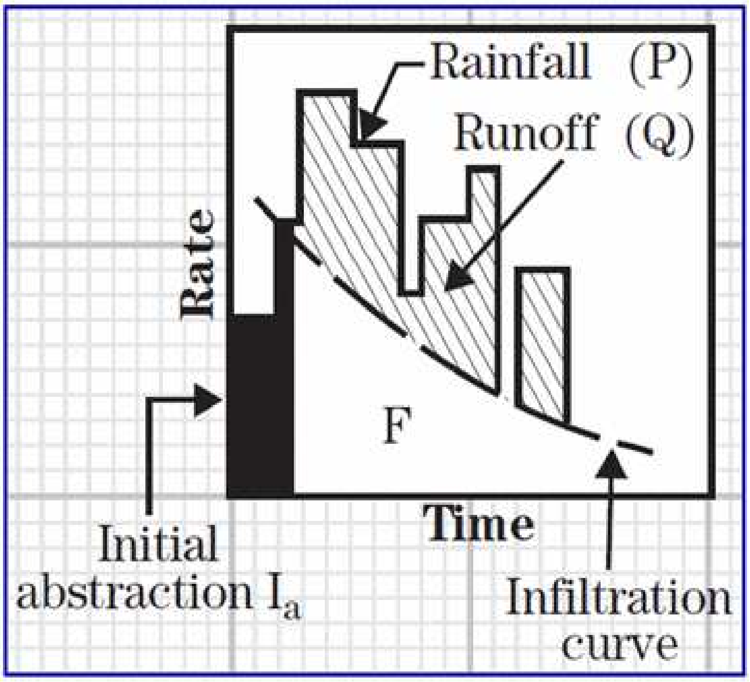
The SCN Method Couples the Water Balance Equation

$$\frac{F}{S} = \frac{Q}{P}$$

Equation 1: Describes the conditions in which no initial abstraction occurs.

Where F = P – Q = actual retention after runoff begins;

Figure 1: Components of SCS Runoff Equation



Source: http://www.professorpatel.com/curve-number-introduction.html)

$$Q = \frac{(P - Ia)^2}{(P - Ia) + S} \quad (3)$$

(Is valid for P≥ Ia WHERE Ia=0.2S)

$$S = \frac{1000}{CN} - 10 \quad (4)$$

Where:

Q = volume of accumulated runoff (in)

P = accumulated rainfall (potential maximum runoff) (in)

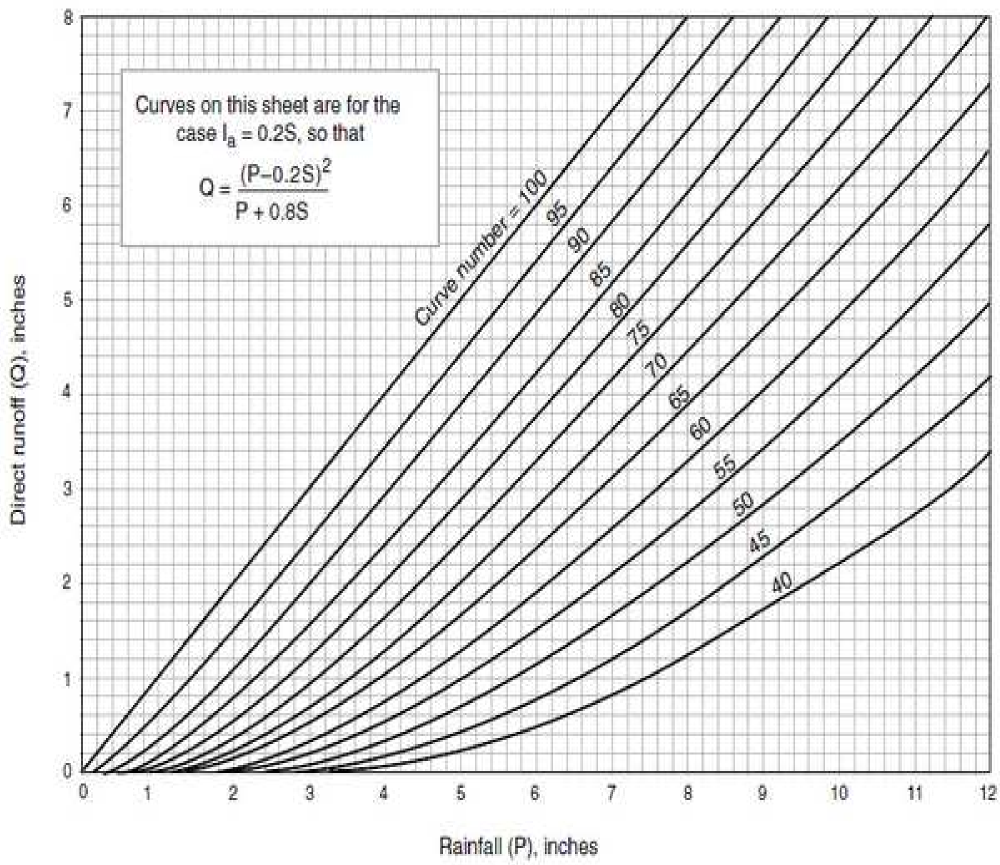
S = potential maximum retention of rainfall on the watershed at the beginning of the storm (in)

Ia = initial abstraction, including surface storage, interception, and evaporation

F = infiltration prior to runoff (in)

Ia is highly variable, but generally is the potential maximum retention *S* is related to the dimensionless parameter CN in the range of $0 \leq CN \leq 100$ by Equation 4

Figure 2



Source: (TR-55, 1986)

STUDY AREA

Analysis of the study in based on Delhi, a mixture of many different types of areas, from those areas we choose Karol Bagh for our study. karol Bagh is 28.6629°N and 77.210°E. The climate of Delhi is monsoon-influenced humid subtropical bordering semi-arid, with high variation between summer and winter temperatures and precipitation. Delhi's version of a humid subtropical climate is markedly different from many other humid subtropical cities. It has relatively dry winters and has a prolonged spell of very hot weather, causing it to be also classified as semi-arid region. Summers start in early April and peak in May, with average temperatures near 32 °C (90 °F), although occasional heat waves can result in

highs close to 45 °C (114 °F) on some days and therefore higher apparent temperature. The monsoon starts in late June and lasts until mid-September, with about 797.3 mm (31.5 inches)[2] of rain. The average temperatures are around 29 °C (85 °F), although they can vary from around 25 °C (78 °F) on rainy days to 32 °C (90 °F) during dry spells. In Karol Bagh, the average high temperatures rise to 34.7 °C here in Jul and fall to 26.8 °C with an average 237 mm of rainfall. The average high temperatures rise to 33.6 °C here in Aug and fall to 26.3 °C with an average 235 mm of rainfall.

RESULTS AND DISCUSSIONS

$$Q = \begin{cases} 0 & \text{for } P \le I_a \\ \frac{(P-I_a)^2}{P-I_a+S} & \text{for } P > I_a \end{cases}$$

$S = \frac{1000}{CN} - 10$

CN=61(according to the data collected for the site)

S=1000/61 -10 =6.393

I_a =0.2S

I_a= 0.2*6.393=1.278

FOR P> I_a

P=70mm for the month of June

Hence, Q= $(P-I_a)^2$/ (P- I_a + S)

Q= $(70-1.278)^2$/70-1.278+6.393=4722.71/75.115=62.8731

FOR P> I_a

P=237mm for the month of July

Hence, Q= $(P-I_a)^2$/ (P- I_a + S)

Q= $(237-1.278)^2$/237-1.278+6.393=5,564.861284/242.115=229.49 mm

FOR P> I_a

P=235mm for the month of August

Hence, Q= $(P-I_a)^2$/ (P- I_a + S)

Q= $(235-1.278)^2$/235-1.278+6.393=240.115 mm

CONCLUSIONS

The curve number was carefully selected for the hydrologic condition of the area. The average high temperatures rise to 38.8 °C here in June and fall to 27.8 °C with an average 70 mm of rainfall. The average value of run off for the month of June came out to be 62.8731mm for the curve number value 61. The average high temperatures rise to 34.7 °C here in July and fall to 26.8 °C with an average 237 mm of rainfall. The average value of run off for the month of July was

carefully calculated to be 229.49 mm for the same value of curve number.The average high temperatures rise to 33.6 °C here in Aug and fall to 26.3 °C with an average 235 mm of rainfall. The average value of run off for the month of August was carefully calculated to be 229.49 mm for the same value of curve number 240.115 mm

REFERENCES

1. *Watershed Hydrology; edited by Vijay P. Singh, Ram Narayan Yadava*
2. *Manvendra Singh Chauhan, Vikram Kumar, Atul Kumar Rahul Research Scholar; IIT BHU; Varanasi: MODELLING AND QUANTIFYING WATER USE EFFICIENCY FOR IRRIGATION PROJECT AND WATER SUPPLY AT LARGE SCALE; International Journal of Advanced Scientific and Technical Research ; Issue 3 volume 5, Sep.-Oct. 2013*
3. *Sk Mishra, JV Tyagi, Vp Singh, Ranvir Singh ;SCS-CN Based Modeling of Sediment Yield; journal of hydrology*
4. *Observation and Analysis of Rainfall-Runoff Characteristics in a Coastal Granite Catchment in Southern China Congsheng Fu1; Jianyao Chen2; and Songqing Zeng3*
5. *Dynamic soil properties for microzonation of Delhi, India C Hanumantharao1,∗ and G V Ramana2*
6. *http://www.professorpatel.com/curve-number-introduction.html*
7. *http://njscdea.ncdea.org/CurveNumbers.pdf*
8. *http://cleveland2.ce.ttu.edu/documents/copyright/MAUTHORS/Mishra_Eval_SCS_CN_Method/Evaluation%20of%20SCS-CN-basded%20model%20incorporating%20antecedent%20moisture.pdf*
9. *http://www.hydrol-earth-syst-sci-discuss.net/6/373/2009/hessd-6-373-2009.pdf*